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ACCREDITATION & QUALITY ASSURANCE CENTER

Course Syllabus

1	**Course title**	Elementary Particles
2	**Course number**	0342466
3	**Credit hours**	3
	Contact hours (theory, practical)	Theory 3
4	**Prerequisites/corequisites**	Quantum Mechanics-1 0332361
5	**Program title**	BSs
6	**Program code**	0302
7	**Awarding institution**	The University of Jordan
8	**School**	Science
9	**Department**	Physics
10	**Course level**	4th-year level
11	**Year of study and semester(s)**	
12	**Other department(s) involved in teaching the course**	-
13	**Main teaching language**	English
14	**Delivery method**	☒Face to face learning ☐Blended ☐Fully online
15	**Online platforms(s)**	☐Moodle ☒Microsoft Teams ☐Skype ☐Zoom ☐Others……
16	**Issuing/Revision Date**	25-7-2024

17 Course Coordinator:

Name: Mohammad Hussein	Contact hours:
Office number: Physics 08	Phone number:065355000-Ext.22023
Email: m.hussein@ju.edu.jo	

18 Other instructors:

19 Course Description:

This course provides an in-depth exploration of foundational physics concepts and principles, Number systems and codes; digital electronic signals and switches; basic logic gates; Boolean algebra and reduction techniques; exclusive-OR and Exclusive-NOR gates; arithmetic operations and circuits; code converters; multiplexers and de-multiplexers; flipflops and registers; practical considerations for digital design; counter circuits; shift registers; multi-vibrators and 555 timer; interfacing to the analog world; microprocessor fundamentals.

20 Course aims and outcomes:

A- Aims:

After successfully completing this course, the student will be able to:

1- Analyze the basic processes in QED.
2- Analyze the basic processes in QCD.
3- Analyze the electroweak theory and Higgs mechanics.
4- Testing the SM predictions: top quark sector and W/Z bosons sector.

B- Students Learning Outcomes (SLOs):

For purposes of mapping the course SLOs to the physics program SLOs, at the successful completion of the physics program, graduates are expected to be able to:

SLO (1) Master professionally a broad set of knowledge concerning the fundamentals in the basic areas of physics: Quantum Mechanics, Classical Mechanics, Electrostatics and Magnetism, Thermal Physics, Optics, Theory of Special Relativity, Mathematical Physics, Electronics.

SLO (2) Apply knowledge of mathematics and fundamental concepts in the basic areas of physics to identify and solve physics related problems.

SLO (3) Utilize computers and available software in both data collections and data analysis.

SLO (4) Utilize standard laboratory equipment, modern instrumentation, and classical techniques to design and conduct experiments as well as to analyze and interpret data.

SLO (5) Develop a recognition of the need and ability to engage in life-long learning.

SLO (6) Demonstrate ability to use techniques, skills, and modern scientific tools necessary for professional practice.

SLO (7) Communicate clearly and effectively in both written and oral forms.

SLO (8) Apply proficiently team-work skills and employ team-based learning strategies.

SLO (9) Apply professional and ethical responsibility to society.

Upon successful completion of this course, students will be able to:

Program SLOs / Course SLOs	SLO (1)	SLO (2)	SLO (3)	SLO (4)	SLO (5)	SLO (6)	SLO (7)	SLO (8)	SLO (9)
1. Analyze the basic processes in QED.	✓	✓							
2. Analyze the basic processes in QCD.	✓	✓							
3. Analyze the electroweak theory and Higgs mechanics.	✓	✓							

4. Testing the SM predictions: top quark sector and W/Z bosons sector	✓	✓							

21. Topic Outline and Schedule:

Week	Lecture	Topic	Intended Learning Outcome	Learning Methods (Face to Face/Blended/ Fully Online)	Platform	Synchronous / Asynchronous Lecturing	Evaluation Methods	Resources
1	1.1	Is the focus of this course Energy Physics or Particle Physics? The Planck length and Max Planck's length are not interchangeable terms.	1	F to F	teams		Exams, In-class quizzes will be given approximately every two weeks and Group presentations	
	1.2							
	1.3	The syntheses of Newton, Maxwell, and Einstein differ from the synthesis of the Standard Model (SM), which is represented by SU(3)xSU(2)xU(1).						
2	2.1							
	2.2	What is the reason for having (α/2π) inscribed above Schwinger's name on his tombstone?						
	2.3	Quantum Electrodynamics (QED) and Feynman diagrams.						
3	3.1							
	3.2	It is all about the matrix element.						
	3.3	The s and t channels and the basic QED processes.						
4	4.1	Quantum Chromodynamics (QCD) is a vibrant and "colorful" world.	2					
	4.2	The coupling constant is not constant at all:						

	4.3	Confinement and Asymptotic freedom.						
5	5.1	The quantum vacuum is not void, but exceedingly dynamic.	2					
	5.2	Lecture 11. Parton Distribution Functions (PDF).						
	5.3							
6	6.1	Talk the talk and walk the walk …. Never and ever be a hypocrite! A list of topics will be provided to be presented at the end of the course.						
	6.2							
	6.3	Weak force is undeniably feeble.	3					
7	7.1							
	7.2	The contrast between Wu and parity and Noether and the elegance of symmetry: Women in Physics.						
	7.3							
8	8.1							
	8.2	The electroweak theory and Higgs mechanism: Rule of thumb.						
	8.3							
9	9.1	Tests of the SM: Jet physics.	4					
	9.2							
	9.3							
10	10.1	Tests of the SM: Top quark physics.						
	10.2	Tests of the SM: W/Z bosons physics						
	10.3							
11	11.1	Tests of the SM: Is it possible for an undergraduate student enrolled in PHY 466 to have the courage to test and confirm equation 14.31 from Jackson's electrodynamics textbook?						
	11.2							
	11.3							

12	12.1	Neutrinos oscillation & DUNE.						
	12.2							
	12.3							
13	13.1	Epilogue: The SM is not quite standard						
	13.2							
	13.3	Presentations and oral exams.	1,2,3,4					
14	14.1							
	14.2							
	14.3							
15	15.1							
	15.2							
	15.3							

22 Evaluation Methods:

Opportunities to demonstrate achievement of the SLOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	SLOs	Period (Week)	Platform
Group presentations	30	The essay must focus on a subject within particle physics	1,2,3,4	Last two weeks	Face to Face
quizzes	30	approximately every two weeks, focusing on the content covered up to that point	1,2,3,4	15 weeks	Face to Face
Final Exam	40	All	1,2,3,4	Last week	Face to Face

23 Course Requirements

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(e.g: students should have a computer, internet connection, webcam, account on a specific software/platform…etc):

Internet , computer.

24 Course Policies:

A- Attendance policies: Regular attendance at all learning activities is expected, and unsatisfactory attendance maylead to disciplinary action according to the University of Jordan regulations.

B- Absences from exams and submitting assignments on time: Students may be permitted to make up an exammissed due to illness or other legitimate absence. A doctor's certification before allowing a student to make up an exam due to illness is required.

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior: The University Of Jordan policy will be implemented

E- Grading policy: according to the table above.

F- Available university services that support achievement in the course:

25 References:

1) Required book(s), assigned reading and audio-visuals:

Modern Particle Physics, by Mark Thomson, first published 2013, 3rd printing 2015,
ISBN: 9781107034266, Cambridge University Press. B- Recommended books, materials, and media:

2) Required references:

a. Introduction to Elementary Particle Physics, by Alessandro Bettini, 2nd edition, Cambridge University Press.
b. Introduction to Elementary Particles, by David Griffiths, 2nd edition, Wiley-VCH.
c. Introduction to High Energy Physics, by Donald Perkins, 4th edition, Cambridge University Press.
d. Particle Physics, 3rd edition, by B. Martin & G. Shaw, Wiley.
e. Quarks & Leptons, 1st edition, by Francis Halzen & Alan Martin, John Wiley & Sons.

f. Review of Particle Physics, by Particle Data Group:
One can read, print or order for free at http://pdg.lbl.gov

g. Facts and Mysteries in Elementary Particle Physics, 1st edition, by Martinus Veltman, World Scientific.

26 Additional information:

Draft/Presentation Assignment

Group projects consisting of 2-3 students will contribute 30% towards the overall grade.

- The students are required to compose a critique (5-7 pages long) on a measurement or theoretical concept and deliver it effectively within a 30-minute time frame. The draft must incorporate essential equations, figures, and a comprehensive bibliography. The delivery should closely mirror the content of the written draft.
- The essay must focus on a subject within particle physics. It should be an authentic piece of work, with plagiarism being completely prohibited. The chosen topic needs to be sanctioned by the instructor before **November 4**, and the final draft must be submitted by **December 9**. Following this, students are required to share their final drafts with each other. If you have a particular topic in mind related to particle physics, you can request approval for it. The presentations are set to begin on **December 11**.
- Sources for literature include: arXiv.gov, Annual Review of Particle Physics (http://pdg.lbl.gov/), Physical Review D (http://journals.aps.org/prd/), Physics Letters B (http://www.journals.elsevier.com/physics-letters-b/), Journal of High Energy Physics (http://link.springer.com/journal/volumesAndIssues/13130), Nobel Prize (http://www.nobelprize.org/nobel_prizes/physics/laureates/), CTEQ Summer School (http://www.physics.smu.edu/scalise/cteq/#Summer), TASI Summer School (http://www.colorado.edu/physics/Web/TASI_info.html), Symmetry Magazine (http://www.symmetrymagazine.org/), Textbooks, Research seminars, etc.

Below is a compilation of potential subjects for consideration.:

1. Accelerator physics.
2. Particle physics detectors.
3. The discovery of the Higgs boson.
4. Jet physics.
5. Top quark physics.
6. W/Z Bosons physics.
7. The discovery of neutrino oscillations & DUNE.

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8. The strong coupling constant and Asymptotic freedom.
9. g-factor for electron and/or muon.
10. The discovery of J/ψ charm particle.
11. The discovery of Υ beauty particle.
12. The discovery of the tau neutrino.
13. Dark matter and/or Dark energy.
14. SUSY.
15. Lattice QCD.
16. Mu2e Experiment.
17. Your own topic of interest (undoubtedly within this field).

Name of Course Coordinator: Mohammad Hussein Signature: ---------- Date: ----------
Head of Curriculum Committee/Department: ---------- Signature: ----------
Head of Department: ---------- Signature: ----------
Head of Curriculum Committee/Faculty: ---------- Signature: ----------
Dean: ---------- Signature: ----------